reaction to a lowered calcium has been mental rather than muscular and she has continued to develop cataracts in the absence of tetany spasms. Also, there are in the literature reports of experimental post-operative tetany cataract in which the animals have had no spasms.

I do not believe that the hemorrhages are directly due to a lowered coagulation time of the blood, since the calcium must be much lower before the blood fails to coagulate. The coagulation time was normal in all three cases. Probably the calcium acts merely as a catalytic agent and only extremely small amounts are necessary.

CONCERNING CYCLODIALYSIS IN SIMPLE GLAUCOMA

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The operation of cyclodialysis, introduced by Heine in 1906, has never received the serious consideration in this country that it warrants. The reason for this is not difficult to understand, and is based upon two factors. In the first place, cyclodialysis is not an operation that is universally applicable to all forms of glaucoma, nor even to all stages of simple glaucoma, and before employing the operation certain definite indications and contraindications must be understood. These vary but little from the original indications as laid down by Heine in his first article, and for the various pros and cons the reader is referred to the voluminous literature, a complete compilation of which was made by Schmidt-Rimpler* in 1908, and by Peters† in 1930. In the second place, cyclodialysis must not be regarded as a cure for glaucoma as is the case with an iridectomy or a trephine, but rather as an adjunct to myotic control. Consequently, it cannot be used indiscriminately upon patients who cannot be kept under observation.

* Schmidt-Rimpler: Graefe-Saemisch Handbuch, 1908, Ed. 2, p. 212.

† Peters: Graefe-Saemisch Handbuch, 1930, Ed. 3, p. 322.

It would seem of some import, therefore, to consider the late effects of cyclodialysis upon selected cases that have been observed over a longer period of time. By selected cases is meant—(*a*) cases of simple non-inflammatory glaucoma; (*b*) those which have never shown any inflammatory exacerbations; (*c*) those which have been observed under myotic treatments for at least one month or more; (*d*) cases in which the intra-ocular tension, the vision, and the visual fields fail slowly despite the use of myotics; (*e*) those which have been watched for at least one year after operation. Twenty-seven eyes fulfilled these qualifications. Many times that number were rejected for this series because of inflammatory symptoms, previous operation of some other type, insufficient observation under myotics before operation, or insufficient length of time of observation after operation.

The indications for performing cyclodialysis are definite, and are as follows: *a.* Simple non-inflammatory glaucoma. The operation has small chance of success in the inflammatory type, either acute or chronic, and an inflammatory exacerbation of a simple glaucoma lessens markedly the chances for success. *b.* That type of simple glaucoma that lies just beyond control by myotics. In the earlier stages of simple glaucoma, and in some of the less severe cases, myotics just fail to keep the intra-ocular tension within the so-called normal range, fail to prevent a gradual loss of vision, and fail to prevent a gradual increase in the visual field defects. Only continued observation and close control under myotics can determine such losses. *c.* Simple glaucoma with a high intra-ocular tension and a visual field defect that extends to within 10 degrees or less of the center of fixation. In this type cyclodialysis does not yield a permanent result, but is to be considered rather in the nature of a preliminary operation done to prevent, if possible, the advance of the field defect over the center of fixation, as so frequently happens after any iris cutting operation. *d.* Following a technically

perfect iridectomy that has failed to control increased intraocular tension, cyclodialysis, if performed immediately above the site of the iridectomy and after not too great a lapse of time, has proved to be of great value.

The 27 tabulated cases were based upon indications *a* and *b*.

Case	Age	Eye	Vision Before Operation	Maximum T. Before Operation	Duration of Medication Before Operation	Vision after Operation	Maximum T. after Operation	Relative Size of Visual Field after Operation	Length of Observation after Operation	Remarks
1	64	R.	0.1	71	1 mo.	0	66	0	3 yrs.	
2	63	L.	0.5	48	1 yr.	0.5	29	No chge.	4 yrs.	
3	46	L.	1.2	36	5 mos.	1.2	18	No chge.	1⅓ yrs.	
4	50	R.	0.6	40	3 mos.	0.6	17	No chge.	1 yr.	
5	60	L.	0.1?	41	3 yrs.	0.1?	*	†	7 yrs.	
6	45	R.	1.0	55	2 yrs.	0.1?	28	†	6 yrs.	Cataract
7	65	R.	6/200	57	1 yr.	5/200	20	Decreas.	6 yrs.	
8	65	L.	4/200	62	1 yr.	5/200	40	Decreas.	6 yrs.	
9	33	R.	1.2	54	1 mo.	0.8	28	No chge.	3 yrs.	
10	33	L.	0.6	61	1 mo.	0.8	30	No chge.	3 yrs.	
11	58	L.	0.2	52	4 mos.	0.1?	20	Decreas.	4 yrs.	Cataract
12	70	L.	0.1?	30	1 mo.	0.4	25	No chge.	3 yrs.	
13	45	R.	0.1?	66	3 mos.	0.1?	17	No chge.	3 yrs.	
14	60	L.	0.5	48	3 yrs.	0.6	33	No chge.	5 yrs.	
15	48	L.	0.2	69	2 mos.	0.1?	60	0	4 yrs.	
16	14	L.	1.2	61	2 mos.	1.2	45	No chge.	4 yrs.	
17	59	L.	1.0	38	2 mos.	1.0	26	No chge.	2 yrs.	
18	45	L.	0.6?	60	3 yrs.	0.6	40	No chge.	6 yrs.	
19	52	R.	0.6?	61	4 mos.	0.8	42	No chge.	5 yrs.	
20	52	L.	0.2	79	6 mos.	0.1?	20	No chge.	5 yrs.	
21	35	L.	1.0	51	1 yr.	1.2	*	No chge.	2 yrs.	
22	40	R.	0.8	53	4 mos.	1.2	42	Decreas.	4 yrs.	
23	40	L.	0.8	46	4 mos.	1.2	46	No chge.	4 yrs.	
24	54	R.	0.5	58	11 mos.	0.5	48	Decreas.	3 yrs.	
25	50	R.	0.8?	52	1 mo.	0.1?	25	No chge.	4 yrs.	Cataract
26	62	L.	0	56	4 mos.	0	30	0	3 yrs.	
27	57	L.	L. P.	66	1 mo.	L. P.	*	No chge.	1 yr.	

* Tension normal on finger palpation.

† Fields not obtainable.

No chge. indicates no essential change.

Decreas. indicates slight decrease in visual field.

Although this is too small a number on which to evaluate percentage results, still, a consideration of the cases should include percentages.

A. Failures.—Two cases (Nos. 1 and 15) were absolute

failures (7.4 per cent.). In neither of the cases were the absolute indications adhered to as strictly as they should have been, for both were types that lay well beyond the control of myotics.

B. Partial Success.—Four cases (Nos. 7, 8, 22, and 24) fell into this class (14.8 per cent.). In No. 7, although the tension remained normal, there was a gradual decrease in the size of the visual field; the vision remained unchanged. No explanation was apparent. In Nos. 8, 22, and 24 the tension remained above the upper limits of the so-called normal, and there was a slight decrease in the size of the visual fields, although no change occurred in the visual acuity. In these three cases further operations were performed.

C. Successful.—In this class were 21 cases (77.8 per cent.). In the majority of these the tension remained within the limits of normal, the visual acuity was unchanged, and there was little or no decrease in the size of the visual fields. Whatever minor changes occurred did not interfere with the integrity of the eye as a visual organ except for extraneous circumstances (as in *D*). It must be noticed that in several cases the intra-ocular tension was recorded as above that commonly accepted as normal. I have discussed this point at length in a previous communication, but it might be well to repeat here that many post-operative cases of glaucoma seem to develop an immunity to a degree of tension which in a normal eye is hypertension. One striking case is that of a man with simple glaucoma upon whose left eye cyclodialysis was performed in 1909, 1911, and 1913. For the last twenty-two years the tension in that eye has never been below 33 mm. Hg, and frequently it is as high as 39 mm. Hg. Still the visual acuity has remained normal and there has been absolutely no decrease in the visual fields, nor any paracentral scotoma formation. In this series of successful cases there were five post-operative cases where the intra-ocular tension remained above 30 mm. Hg for years, and five cases where

the tension was between 25 mm. Hg and 30 mm. Hg. All these cases were observed for a minimum period of two years and none showed any malignant influence of this so-called hypertension.

D. Cataract Formation.—In three cases (11.1 per cent.) cataract developed slowly after the operation, and influenced vision materially. I believe that this percentage is too low, and with a larger series of cases there will be a higher proportion of lens opacities. Many of the opacities are due to the mild uveitis that frequently follows a cyclodialysis, but many more are probably due to the trophic disturbance that follows the forcible severance of the ciliary nerves, and possibly to the interference with the function of the anterior surface of the iris. This is in line with the experimental cataract formation in rabbits which followed the application of ultra-red rays to the anterior surface of the iris alone. However, it is not probable that there is any greater danger of cataract formation after cyclodialysis than after any of the iris cutting operations.

E. Increase in Vision.—There was an actual increase in vision of 10 per cent. or more in six cases (22.2 per cent.). I believe this percentage to be too high. Such an increase in the vision as occurred cannot be accounted for except on theoretical grounds which are none too sound.

Thus the percentage analysis is as follows:

Failure—2 cases (7.4 per cent.)
Partial success—4 cases (14.8 per cent.)
Successful—21 cases (77.8 per cent.)
Cataract formation—3 cases (11.1 per cent.)
Increase in vision—6 cases (22.2 per cent.)

CONCLUSIONS

A. Cyclodialysis offers chances of success in practically 80 per cent. of the cases provided the indications for the use of the operation are adhered to.

B. The indications for the use of cyclodialysis in simple glaucoma are:

a. Pure simple glaucoma without inflammatory reaction.

b. That type of case in which the continued use of myotics just fails to maintain the integrity of the visual fields, the visual acuity, and the balance of the intra-ocular tension.

c. The malignant simple glaucoma in which the peripheral defect of the visual field reaches to within 10 degrees of the point of fixation.

C. Cataract formation occurs in slightly more than 10 per cent. of the cases after cyclodialysis.

D. Where proper indications exist, cyclodialysis is to be preferred to iridectomy or fistulizing operations because of—

a. Less damage to the integrity of the eye as a visual organ.

b. Less danger of immediate post-operative complications.

c. No danger of late infection.

d. Possibilities of repetition if unsuccessful.

DISCUSSION

DR. T. B. HOLLOWAY, Philadelphia: Probably the majority of the members present have resorted to this operation at one time or another. Personally, I have used cyclodialysis for the simple glaucoma to which Dr. Gradle referred; I have used it also in another type of glaucoma, where marked contraction of the field makes iridectomy practically prohibitive; and I have used it after failure to maintain reduction of tension following iridectomy or trephining.

I think Dr. Gradle has rather over-emphasized, so far as my experience is concerned, the cataractous changes that result from this operation. I have found that these changes are not as frequent after cyclodialysis as they are following a trephining operation.

I would like to make one suggestion to those who may resort to this operation, and that is, that they do with their cyclodialysis cases what has been advocated after trephining, namely, institute early massage, and keep up the massage of the globe as long as

the patient is under observation. I am sure it has been of the utmost service to me. I begin twenty-four hours after the operation, and each day when the eye is dressed the cornea is massaged.

DR. W. H. WILMER, Baltimore: A few years ago I visited one of the large Continental clinics. The first operation that morning—at eight o'clock—was the fifth cyclodialysis on a comparatively young patient. After completing the operation, the operator, a distinguished and a skilful surgeon, said: "You see, my dear colleague, it has the great advantage that we can do it indefinitely." It seems to me that this shows that it is a comparatively safe operation, but not one of the most effective in simple chronic glaucoma. However, there is one type of glaucoma, in which cyclodialysis has been of value, that has not been mentioned, that is, in elderly people with marked vascular hypertension, retinal hemorrhages, and high intra-ocular tension—about 47 mm. Hg, Schiötz—somewhat dangerous cases in which to do corneo-scleral trephines. In these cases I have had good results from cyclodialysis followed by myotics, and, as Dr. Holloway mentioned, by immediate massage. But my results have nearly always been poor in those cases in which, in addition to increased intra-ocular tension and retinal hemorrhages, there was a mild uveitis.

DR. GEORGE E. DE SCHWEINITZ, Philadelphia: I have had a fairly large, personal experience with cyclodialysis and the results have been reasonably successful. I quite agree with the essayist that after cyclodialysis myotics act better than they do prior to its performance.

As Dr. Wilmer has pointed out, in cases of chronic glaucoma, associated with fundus hemorrhages, cyclodialysis is safer than other operative procedures. I have never employed cyclodialysis in acute glaucoma, and do not think it is a proper operation in this type of glaucoma.

Occasionally after cyclodialysis a small triangular iridodialysis remains, a complication to which Meller refers as one of no moment; indeed if anything, it enhances the value of the procedure.

I have never seen a disaster after cyclodialysis, in the sense of the loss of an eye, because of the operation. Naturally the operation may fail to control the increased tension, but it may be repeated or may be followed by a more formal procedure. The quiet iritis, so often evident after corneo-scleral trephining, is rare in my experience; in one patient, several years after a successful cyclodialysis,

it appeared in the form of an unusually extensive deposit of brown pigment grains on the lens surface; there was no synechia.

I am convinced that cyclodialysis has a distinct value in our operative technique for the relief of glaucoma, employed in the cases so well defined by Dr. Gradle.

DR. WILLIAM ZENTMAYER, Philadelphia: I would like to add my testimony as to the value of cyclodialysis. I have frequently performed it and have found it a valuable procedure in most of the classes of cases that Dr. Gradle has mentioned. I have saved several eyes with secondary glaucoma following obstruction of the central vein of the retina by this operation. In one case I succeeded in reducing the tension sufficiently to permit of the performance of an iridectomy afterward.

DR. P. CHALMERS JAMESON, Brooklyn: I would like to emphasize the point that Dr. Holloway has just stated; that is, that cyclodialysis is an operation by which we secure slower drainage. One of the reasons for lens changes immediately following an operation producing a sudden reduction of tension is the stretching of the capsule, which causes a fracture of the latter. Cyclodialysis gives us an operation which causes more gradual, and therefore safer, drainage.

DR. M. J. SCHOENBERG, New York: It seems to me that Dr. Gradle's cases would have given equally good results if operated upon by other methods (Lagrange, Elliot, or iridotasis). A marked limitation of the field of vision is, in my experience, no contraindication for an operation. The patients I operated on by cyclodialysis did not do better or worse than those operated upon by other methods. I believe that Dr. Gradle's effort to establish definite indications for the Heine operation is a step in the right direction, and I hope he will continue his studies. Occasionally one meets cases of secondary glaucoma in which a cyclodialysis is the only procedure that may reduce the hypertension. Cases of this sort have been reported in the literature, and I have had one with very gratifying results. I wish to ask Dr. Gradle whether he has observed many cases of detachment of the Descemet membrane after a cyclodialysis and, if so, what became of that detachment in the course of years. My experience agrees with that of Dr. de Schweinitz in regard to the technique of the Heine operation. Whenever the dialysis was not sufficiently extensive the operation had to be repeated.

DR. ARNOLD KNAPP, New York: I wonder if your experience is the same as mine—that success depends on the absence of any trauma. When the patients were unfortunate enough to develop a hemorrhage in the anterior chamber the result was not so favorable.

DR. HARRY S. GRADLE, closing: I cannot agree with Dr. Knapp that hemorrhage into the anterior chamber negatives the results. In a large proportion of cases the separation of the ciliary body from the sclera is carried out to a sufficient extent to be a valve in preventing this hemorrhage, and, as a rule, any hemorrhage will absorb completely in from two to five days. I have not found that it has any material influence upon the end-result. In this connection, I also wish to state that a mild uveitis following cyclodialysis is, in my experience, rather common, and I do not object to it in the slightest. I believe a mild uveitis is a definite factor in reducing or maintaining the reduction of intra-ocular tension.

Several points arose in the discussion. In the first place, cyclodialysis is not an operation for use on the average clinical patient. It is not a cure for glaucoma; it is an adjunct to treatment; but with a patient who is careless, who cannot be kept under control, who cannot see the seriousness of the condition and will not use myotics, there is no justification in performing this operation.

In addition to the massage that Dr. Holloway mentioned, I always use homatropin at the conclusion of the operation, and usually for two or three days afterward. Myotics are seldom used until a week or ten days after operation, or until all inflammatory reaction has subsided, and then in somewhat weak concentration and at comparatively infrequent intervals—once a day.

Regarding the question of the reduction of the field of vision of which Dr. Schoenberg has spoken, I grant you if the field is cut down to within 5 degrees or 10 degrees of the point of fixation, it will not *necessarily* be wiped out after an iridectomy or trephine, but that circumstance could happen after any iris cutting operation, which does not apply in the case of cyclodialysis. I also agree that the cases which I call "selected cases" would probably have done as well with a Lagrange or a trephine, but the eye was subjected to less injury by cyclodialysis than it would have been by trephine, Lagrange, or any operation for cutting the iris.